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A mesocosm study design using undisturbed soil monoliths

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1. Introduction

A well-entrenched concept in soil zoology states that, besides other invertebrates, microarthropods and Enchytraeideae influence biological and chemical processes in soil via their influence on microbial populations. A considerable number of laboratory studies has shown that grazing may stimulate microbial respiration, enhance microbial growth rate, and influence the mobilization of nutrients. Due to the simplicity of these studies ("microcosms" in Odum 1984) the results are highly dependent on the particular experimental conditions. For instance, the patterns of interaction between Collembola and fungi may depend on animal densities (Ineson et al. 1982), nutrient concentrations (Hanlon 1981) or the spatial complexity of the experimental setup (Leonard & Anderson 1991). Microcosm studies can give valuable hints, how mutual effects between soil biota may look like. The ultimate evaluation of the initially stated hypothesis that the mesofauna could be able to influence soil processes, however, can only be performed in the field.

To bridge the methodological gap between the laboratory and the real world, Odum (1984) suggested the use of bounded and partially enclosed outdoor experimental setups, so-called "mesocosms". Mesocosms can be replicated and offer a high degree of realism simultaneously. Only a very little number of mesocosm studies have yet been conducted by soil zoologists. These investigations have not been performed under undisturbed field conditions. Teuben (1991) included only the F1-layer of *Pinus nigra* forests into the mesocosms and restricted the microarthropod community to a single Collembolan species. Faber & Verhoef (1991) used artificial organic layers with dried, mixed, and sieved litter material in their field enclosures. However, these manipulations are suspected to effect the magnitude and even the direction of treatment effects (Wright et al. 1989). We are of the opinion, that mesocosms could serve as a tool for the demonstration of animal effects under true field conditions. We therefore try to avoid manipulations of natural conditions as far as possible and suggest the use of undisturbed soil and litter substrate as well as the inclusion of the entire microfloral and mesofaunal community in the mesocosms.

2. Study sites, methods, and preliminary results

Our investigations were carried out in a 40 years old *Picea abies*-site in Styria, Austria. For the production of mesocosms we used pairs of chromium steel frames (inner and outer frame) which fit into one another tightly. The outer frame measured 25 × 25 × 15 cm. 30 soil monoliths were removed from the ground using the inner frames. The frames were driven in the ground and dug free on one side. The bottom of each monolith was cut with a metallic plate. The monoliths were partially sterilized by rapid deep-freezing with solid carbon dioxide to temperatures of at least −15°C. We preferred deep-freezing to other sterilization methods because of minimal side-effects on soil physical and microbial properties (Huhta et al. 1989).

Three treatments were applied to the monoliths:

1) 10 blocks were wrapped in fine nets of 35 µm meshsize to exclude meso- and macrofauna.
2) 10 blocks were wrapped in coarse nets of 1 mm meshsize to allow for the immigration of microarthropods and Enchytraeidae but to exclude macrofauna.
3) 10 blocks were left uncovered to allow for the immigration of the entire animal community.

30 cavities (set randomly on the study site) were prepared using the outer frames. The frames were driven

Table 1. Mean ± *SD* of numerical abundance of mesofaunal groups in cores from the differently treated mesocosms (*n* per treatment = 10) and results of ANOVA with log-transformed data and subsequent Tukey-tests. The size of each core is 385 cm^3.

	1 Fine net	2 Coarse net	3 No net	4 Control	Significant differences between
Enchytraeidae	6.5 ± 8.1	119.3 ± 44.2	132.1 ± 37.9	116.6 ± 62.3	1 and 2, 3, 4
Collembola	2.1 ± 2.1	125.7 ± 80.0	119.9 ± 46.4	86.2 ± 51.5	1 and 2, 3, 4
Acarina	17.2 ± 11.2	136.9 ± 86.7	280.5 ± 107.5	1124.2 ± 265.1	all pairs
Others	1.5 ± 1.6	16.7 ± 11.5	17.4 ± 9.2	26.7 ± 13.1	1 and 2, 3, 4

in the ground, left in this position, and the soil material inside was scraped out. The 30 monoliths were lowered into the cavities. After removal of the inner and outer steel frames the nets were closed. Remaining gaps around the monoliths were filled with sieved soil.

4) 10 control blocks were left unremoved and unmanipulated. The comparison of treatments 3 and 4 shall permit the detection of methodological handling effects (Huhta et al. 1989). The mesocosms were exposed for eight months (October 1991 to June 1992).

A broad spectrum of soil microbial (e.g. biomass, activity of various enzymes) and chemical investigations are currently conducted in order to analyze the effects of the partial exclusion of faunal elements. Our zoological results indicate that (Table 1)

1) deep-freezing is a well-suited method to eliminate the active stages of soil meso- and macrofauna,
2) the fine nets were very efficient in keeping out meso- and macrofauna from the mesocosms,
3) the immigration of Enchytraeidae and collembolans to mesocosms wrapped in coarse nets was not hindered, whereas the density of Acarina in the treatment with coarse net was significantly lower than in the control.

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